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# Non-Structural Control Strategies for Nonpoint Sources of Water Pollution (Supplemental Report) Areawide Waste Treatment Management Plan for the Greater Houston Area (Section 208, P.L. 92-500)

Houston-Galveston Area Council, TX

Prepared for

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# NON-STRUCTURAL CONTROL STRATEGIES FOR NONPOINT SOURCES OF WATER POLLUTION

## SUPPLEMENTAL REPORT

SEPTEMBER 1977

HOUSTON-GALVESTON AREA COUNCIL

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This report is supplement to document Control Strategies, Costs and Impacts for Nonpoint Sources - July 1977. The nonstructural alternatives are those that are primarily implemented through governmental regulation of, or influence upon, land development activity. The various aspects explored to control nonpoint sources of pollution are: a) controls over location of land development, b) controls over form of land development, and c) the coupling of control influencing both form and location. Due to the uniqueness of agricultural nonpoint source pollution, these controls are treated separately. Finally, it concludes with discussion of E.P.A.'s general permit program and its reliance on nonstructural controls as part of expanded NPDES permitting process.

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# NON-STRUCTURAL CONTROL STRATEGIES FOR NONPOINT SOURCES OF WATER POLLUTION (SUPPLEMENTAL REPORT)

AREAWIDE WASTE TREATMENT MANAGEMENT PLAN
FOR THE
GREATER HOUSTON AREA
(SECTION 208, PL 92-500)

SEPTEMBER 1977

PREPARED FOR THE HOUSTON-GALVESTON AREA COUNCIL
BY JAMES B. BLACKBURN, JR. AND PETER G. ROWE

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## INTRODUCTION

Planning agencies involved in Section 208 analysis must consider the control of nonpoint sources of water pollution. Depending upon the impact of nonpoint sources in a particular area, a decision must be made concerning whether or not nonpoint sources are of a magnitude substantial enough to require controls. Secondly, a decision must also be made concerning the form of the controls if they are found to be necessary. At this point, a decision-maker needs to be informed of the full gamut of possible controls so that those appropriate to an identified problem may be chosen. The following narrative is a presentation of non-structural control alternatives that may be applicable to the control of nonpoint sources. This report is intended to supplement the document titled "Control Strategies, Costs and Impacts for Nonpoint Sources", prepared as part of the Greater Houston Area Waste Treatment Management Study (under Section 208, P.L. 92-500).

### Nonpoint Sources and First Flush Effects

When rain falls upon the land surface and runs off into adjacent water bodies, it carries with it various particles and chemicals that are on the land surface. Those particles and chemicals conveyed by rainfall runoff into an adjacent stream are termed nonpoint source pollution, and the magnitude of their occurrence is related to the type of land use, the presence or absence of vegetation and other physical variables. Nonpoint source pollution is therefore a dispersed phenomena, and its sporadic nature and constituency as well as its volume often makes "end of the pipe" treatment technology economically unattractive, particularly when compared to the economic feasibility of either municipal or industrial point source wastewater treatment systems.

The "first flush" effect occurs when stormwater initially drains from the land surface and refers to the physical nature of nonpoint source pollution. When rainfall runs over land surface, it picks up pollutants lying on the land surface. The transporting of many of these pollutants occurs at the onset of runoff, and although some entrainment will occur throughout a storm event, the majority of the pollutants will be removed initially. Therefore, runoff early in a storm event will have a higher concentration of various pollutants than will runoff occurring near the end of a storm event. The major loading of nonpoint source pollution will occur during this first stage of runoff generation, leading to the term "first flush" effect. The impact of nonpoint source pollution upon a stream segment will most likely be greatest when this first flush empties into the stream segment.

## Structural and Nonstructural Control Strategies

In discussing the control of nonpoint sources, a distinction must be drawn between structural and nonstructural solutions. For purposes of this report, a structural solution is considered to be a capital works solution involving the application of "end of the pipe" waste treatment technology. A structural solution would be exemplified by a stormwater treatment plant. Nonstructural alternatives are those that are primarily implemented through governmental regulation of or influence upon land development activity. As used herein, nonstructural does not mean that a physical alteration of the natural system is not contemplated, but rather that the primary implementation mechanism is a regulatory or legal control. A retention pond being required at the subdivision plat approval level would be an example of a nonstructural approach that does lead to an alteration of the physical environment. However, the emphasis is upon the subdivision plat approval process, rather than upon the physical alteration per se. Therefore, the discussion that follows will necessarily have a legal orientation.

The discussion of alternative types of nonstructural controls must focus upon the general types of solutions that may be implemented, at least conceptually. Nonstructural controls may dictate the location, the form, and even the timing of land development activity. Assuming that a technical basis exists that documents the relationship between certain types of land development activity and nonpoint source pollution, the control of the location and the form of the development may offer the most practical and least expensive manner of nonpoint source control.

## Organization of the Report

In the sections that follow, various aspects of nonstructural control of nonpoint source pollution will be explored. Initially, controls over the location of land development will be presented. Next, controls over the form of land development will be considered, including an overview of subdivision level control mechanisms. The coupling of controls influencing both form and location as well as other aspects of integration will also be presented. Agricultural nonpoint source controls will be treated separately, due to the unique problems associated with agricultural nonpoint source pollution. Finally, this report will conclude with a discussion of the Environmental Protection Agency's general permit program and its reliance upon nonstructural controls as part of the expanded National Pollutant Discharge Elimination System (NPDES) permitting process.

## TECHNIQUES INFLUENCING THE LOCATION OF DEVELOPMENT

There are four general types of nonstructural controls that may influence where development occurs. These are: (1) regulatory controls such as zoning, (2) land or easement purchase, (3) tax incentives or tax programs, and (4) infrastructure placement. The initial assumption involved in the consideration of any of these alternatives is a relationship between the location of the development and the dissipation of the impact in the stream. Secondly, it would need to be documented that controls emphasizing where development occurs are less costly (either in terms of governmental expenditure or in terms of the impact upon the housing consumer) than nonpoint source controls influencing how development occurs.

Current technology is able to calculate the assimilative capacity of a stream during low flow conditions. This assimilative capacity is the ability of the stream to absorb various waste materials while maintaining an acceptable stream water quality (i.e., standards). However, it is more difficult to assess the ability of a stream to assimilate waste during wet weather conditions. At this time, technical models are under development that will be able to calculate wet weather assimilative capacity and stream responses to nonpoint source pollution. The development of this modelling capability is an important element in determining the applicability of techniques influencing where development occurs.

As rain falls on the land surface, nonpoint source pollutants are added to the stream via surface water runoff. This increased flow within a stream will lead to an increased ability to assimilate wastes (i.e., more dissolved oxygen), while at the same time the total loading of pollutants would be increased via the overland flow. The dynamic models under development will be able to predict the resultant stream quality for certain storms and certain land use patterns.

Using these dynamic models, an "optimal" intensity of land development within watersheds of a given stream segment may be determined. As such, existing development practices would be considered as input, with the optimization being specified in terms of a certain percentage of land area being developed in each watershed. In this manner, a determination could be made that, for example, 25% of every small watershed could be developed under existing development practices. The impact of nonpoint source pollutant inflows resulting therefrom would not exceed the stream assimilative capacity. In this manner, no direct expenditure of dollars for nonpoint source controls would be required. However, a control system would have to be developed that would influence "where" development could occur; namely, on 25% of the identified watersheds, and development of the

remaining 75% would have to be restricted. Although this example does not address how the "developable" 25% would be determined, it does indicate that mechanisms restricting development in the remaining 75%, "where" mechanisms, would be needed.

Technically, a determination would have to be made of the optimal placement of land development on a small watershed basis. At this time, land development is used only to refer to residential, commercial, or industrial activity. Agriculture and agricultural land development are considered separately in another section of this narrative. Once such a technical determination was made, the question of how the location of land development could be influenced must be addressed.

## Regulatory Controls

Regulatory controls refer to the ongoing ability of certain levels of government to limit individual or personal rights in the interest of the public's health, safety, or welfare. While there are many types of regulations, one of those which may influence the location of land development is zoning.

### Zoning

Zoning became popular in this country near the turn of the century and was upheld as constitutional in the landmark case of the City of Euclid vs. Ambler Realty Co., a 1926 U.S. Supreme Court Decision. Once the State has given the appropriate level of government the power to enact a zoning ordinance, the zoning approach would identify uses to which land may be put based on a comprehensive plan. This determination would then be codified in a zoning ordinance, with an official map. The results of the zoning process are displayed on a map, with the potential for various development types located as to specific sites. Inadvertently, the use of this power has the tendency to predetermine land values, since certain land development types may generate a higher land price than other development types. Sone uses, such as open space, may not have much market value at all. Nonetheless, zoning is a very powerful mechanism for determining where various types of land development may occur.

There are several problems with the implementation of this approach in the Houston-Galveston Area. First, only municipalities are enabled to enact zoning ordinances for application only within their municipal boundaries. Counties do not have general zoning power, and cities may not zone their areas of extraterritorial jurisdiction. Therefore, much of the necessary authority for enacting these controls is absent in portions of the Greater Houston 208 area. Second, the City of Houston has not utilized enabling legislation, choosing instead to allow the private market system to arbitrate land use

decisions. Therefore, a political predicate is lacking. Third, the delineation of zone boundaries will undoubtedly raise problems of equity. For example, if the nonpoint source model (referred to earlier) were able to give an output indicating that 25% of a particular watershed could be developed as single-family residential without generating excessive amounts of nonpoint pollutants, the question still remains concerning which land parcels were to be selected for development. In other words, the owners of 75% of the land in the example would be prevented from developing their land; yet their land may be the same in accesibility and physical characteristics as the neighboring land. Therefore, even if a technically supportable basis for zoning were developed, practical problems seem to restrict its use for nonpoint source control.

Transfer of Development Rights

Zoning is not the only mechanism available, nor are the problems it creates insurmountable. The greatest difficulty with zoning does seem to be the equity problems raised by the process. In other words, some landowners are able, as a result of the imposition of a zoning ordinance, to realize substantial value from the sale of their land, whereas other landowners may receive less money due to their zoning classification. One approach that begins to address this equity problem is transfer of development rights.

Transfer of development rights is a technique whereby the government restricts the ability of certain persons to use their land (i.e., open space zoning) and allows other landowners to develop their land if certain conditions are met. A central concept of this technique concerns the separation of development rights from fee simple ownership. For example, mineral rights may be bought and sold even though the ownership of the surface is retained. Similarly, development rights are considered under this concept as being analogous to "mineral rights". As is the case with mineral rights, development rights may be bought and sold without the ownership of the land surface changing. As such, the transfer of development rights would apply to nonpoint source controls much as zoning would. However, a commodity (i.e., development rights) has been introduced into the zoning concept.

Under transfer of development rights, certain conditions are specified regarding land development. Generally, minimal development is allowed without the necessity for a transfer of development rights. However, if developers wish to build at densities beyond those allowed, they must purchase development rights from a landowner whose land has has been identified as non-developable. The number of development rights purchased determines the ultimate density allowed. The system is characterized by negotiations between landowners, with the strength of the approach being the fact that a mechanism is established whereby the landowner with no development option gains compensation from

another private sector participant. In other words, the system is more equitable than a pure zoning system.

The application of development rights transfer to nonpoint sources, however, seems limited. Development rights transfers seem most appropriate where a small area is being restricted and a larger area is allowed for development purposes. Specific applications have generally been limited to the preservation of historic buildings and a potential application would exist in the protection of unique or critical environmental areas (i.e., an endangered species habitat, unique vegetation, wetlands, etc.). In the example showing the limitation of development for nonpoint source purposes, it was contemplated that 75% of identified watersheds would be left in an undeveloped condition. The necessity to provide equity to 75% of a given area from the 25% allowed to develop would be a problem of apparently insurmountable magnitudes. Therefore, it would seem that the transfer of development rights, in instances such as the 75%/25% example, would be less applicable to nonpoint source controls than to other problem types.

## Fee Simple or Easement Purchase

A second group of techniques influencing where development may occur exists in fee simple or easement purchase programs. These programs may be used either independently or in association with zoning. They are characterized by the landowner being compensated for a limitation of his development potential, with the government providing the funds for the purchase price. This latter fact is a major point of differentiation between development rights transfer and acquisition programs.

### Fee Simple Purchase

Fee simple purchase is the buying of lands from a seller at full market price. The program may involve either a willing buyer/willing seller situation, or it may be brought about by land condemnation through the use of eminent domain. Such transactions are common in highway right-of-way and flood control projects. The major legal condition to the use of eminent domain is the requirement that an overriding public interest be present. However, more practical limitations may be found in: (1) the administration by the public of condemned land, (2) the attitude of landowners toward fee simple condemnation, and (3) the problem in dollar terms, of amassing the large amounts of land required to limit land development for nonpoint source controls. Therefore, while fee simple acquisition is unquestionably successful in limiting development, its application to the large land areas required under the nonpoint source control scenario limit its applicability to the 208 program.

## Easement Purchase

A more viable option may exist in the purchase of easements over large land areas. These easements may be viewed conceptually as the purchase of the development rights to various land parcels, rather than as fee simple acquisitions. In this manner, the landowner retains title to the land and all land development rights except those specifically precluded by the easement. The most successful application of this concept has been with respect to the preservation of agricultural lands and wetlands.

The easement program is most easily implemented on a willing buyer/willing seller basis, although condemnation powers may be applicable to easement as well as fee simple acquisitions. A program instituted by Suffolk County, New York for the purpose of preserving prime agricultural land involved the invitation to land owners to set a price on their development rights, with those "bids" being sealed and opened at one time. Then, the County decided which land parcels and prices were most attractive and accepted those bids. In this manner, the desired end was reached at a much lower cost than would have resulted from fee simple acquisition. Thus, the program could be applied to larger geographic areas.

The initiation of such an approach in the Houston area would be novel, to say the least. The success of the use of this technique would lie in the ability to begin such a process as soon as possible, due to the fact that the market value of certain lands increases daily. In fact the large amount of land syndication activity currently underway may already limit the applicability of the technique. At this time, agricultural land values may be approximately $1,000 per acre; speculative value may be $5,000 per acre; and real estate developers may pay as much as $20,000 per acre in faster developing areas. Therefore, the sale of development easements is more realistic in the more rural areas of the 208 project area. Nonetheless, certain owners of large land parcels may wish to preserve their land from development pressures and higher taxes, and such an easement purchase program could be very effective if used in conjunction with other techniques to be discussed later.

## Tax Incentives

A third group of techniques that may influence the location of development is taxation policies. In particular, ad valorem tax policies may be administered in a manner that offers inducements to landowners not to develop their land. While the possibility exists that constitutional problems may be encountered in the application of these techniques, certain types of programs have been upheld as constitutional.

The major precedent in Texas lies in the preferential tax assessment of agricultural lands. Under this constitutional provision, land may be taxed at its agricultural use value, rather than at its speculative land value. In this manner, a farmer is not forced to sell his land due to an inability to pay land taxes based upon speculative land values. However, the Texas law applies only to agricultural lands and contains provisions restricting the applicability of this piece of legislation in preserving agricultural areas (see Agricultural Section). A tax incentive program for all of the 208 land area slated for nondevelopment under the hypothesis of 25% development, 75% nondevelopment would require alteration of this existing preferential tax system. Therefore, while this existing program for use-value taxation may augment an overall approach, the current structure precludes wide scale application.

## Infrastructure Placement

A fourth set of techniques influencing where development takes place involves selective placement of infrastructure items. In particular, the location of sewer lines and treatment plants (and their service areas) and drainage facilities, as well as the location of public roads, have a very large influence upon land development practices. In fact, these indirect control methods may be more successful than direct controls such as zoning, where the control may be circumvented by variances and other exceptions. Due to the nature of the 208 program, the ability to influence the location, size, and areal coverage of sewage treatment plan service areas is well within the current scope of the program. Whether or not this mechanism should be used to control where land development occurs is another question, but the possibility certainly exists.

## Conclusion

Four potential sets of techniques influencing "where" land development may occur have been presented. However, it should be noted that the use of such techniques to address nonpoint source pollution alone is perhaps the most undesirable aspect of this alternative. Although the technical linkage may exist between the location of land development and nonpoint source controls, the linkage is more clearly documented with respect to such variables as vehicle miles travelled (energy consumption and air pollution), environmentally sensitive areas, and agricultural preservation. Those most promising alternatives, the easement purchase and the infrastructure siting mechanisms, avoid the problems of direct land use controls, and their use in combination with other techniques may be highly desirable. Undoubtedly, the use of techniques influencing "where" development may occur would have numerous collateral or ancillary benefits, particularly if the nonpoint source considerations were totally integrated with other programs such as transportation planning, flood control, and

agricultural preservation. However, the conclusion is that techniques concerned solely with "where" development occurs will not satisfactorily address the needs of a nonpoint source control program.

## TECHNIQUES INFLUENCING THE FORM OF LAND DEVELOPMENT

A second major classification of non-structural alternatives would involve those concerned with "how" land is developed without concern for where development occurs. Although certain of the techniques previously discussed in the "where" section may be valid, a number of alternative legal mechanisms are available at the "how" level that are not applicable at the "where" level.

Concern with how development occurs addresses a wide range of variables related to nonpoint sources of pollution. Erosion during construction activities may be considered separately from control of pollutants generated by a completed development. The amount and duration of clearing activities, the size of the area devegetated, the type of drainage system, the amount of runoff generated, the amount of impervious area and even the mix of housing types may all be variables addressed in a comprehensive nonpoint source control program.

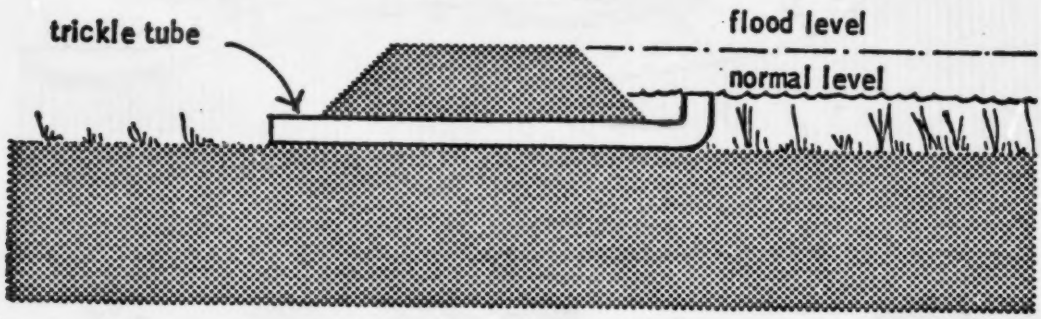
### Measures in Development Form For Nonpoint Source Reduction

Prior to exploring the legal implementation mechanisms available for influencing the form of land development, an overview of various subdivision level alternatives, including a summary of environmental and economic effects, will be set forth. The controls presented in this section are all concerned with either the partial absorption or detention and slow release of urban runoff. In addition to reducing peak flows and mitigating the first flush effect from a storm event (through the detention process), many of these techniques also reduce the total mass of pollutants discharged into receiving streams. For instance, the use of detention ponds or other similar catchment areas allows suspended solids to settle out prior to discharge. In this manner, the concentrations of suspended solids in the runoff that is ultimately discharged are reduced. Similarly, the decomposition of oxygen-demanding materials occurs as a function of time. Temporary detention or ponding of runoff may allow this decomposition to take place prior to discharge into receiving water bodies. Nutrients may also be removed through contact with aquatic vegetation species residing in or on the periphery of retention ponds and swales. The following are several alternatives that may be applied at either the small watershed, subdivision or lot level. All are concerned in some way with detention or partial absorption of runoff, and several of these alternatives involve time release. Information concerning typical costs of these alternatives is presented in Tables 1 and 2 following the description of the alternatives.

## Retention Ponds Reservoirs

A retention pond usually takes the form of a partially excavated, partially leveed reservoir with sufficient excess capacity to contain a certain level of stormwater. These retention ponds are combined with traditional drainage systems to allow slow release of the excess stormwater. In terms of various types of pollutant loadings, retention ponds are most effective in lowering concentrations of suspended solids, as described in the discussion above. They can also be effective in lowering the concentrations of other types of pollutants including oxygen-demanding materials and nutrients. By forming an integral part of a project's landscape design, retention ponds can be used as a recreational amenity as well as offering the opportunity for recycling water resources to service various portions of the development. There are certain limitations to the types of developments that may include the larger scale retention-type solutions, although the use of retention ponds as part of the public infrastructure servicing several developments might be encouraged. (For a more detailed discussion of retention ponds, see Chapter VII of the Non-point Source Control Strategies, Costs and Impacts Report.)

FIGURE 1
TYPICAL STORMWATER RETENTION POND
OUTLET MECHANISM




## Swales

"Swales" is a generic term generally appied to above ground drainage depressions. In practice, these may take on various sizes and forms. First, a system of natural drainage swales may exist as a physical characteristic of the hydrologic regimen within a development area. By retaining these "natural" drainage swales within site design, the release of excess urban runoff occasioned by development may be detained and partially absorbed into the soil. Additionally, the presence of vegetation within the swale may further add to the reduction of water velocity, thereby aiding settling, while also "scavenging"

suspended solids from the water. Catchment areas analogous to a natural drainage swale, under suitable topographic conditions, can be artificially created as a part of a site's open space or landscape design. The retention capacity of these swales (both natural and artificial) can be augmented by small check dams. These check dams can be particularly effective when the checkdam is spatially coincident with permeable soils. (See Chapter VII of the Nonpoint Source Control Strategies, Costs and Impact.)

FIGURE 2
NATURAL SWALE OPERATION

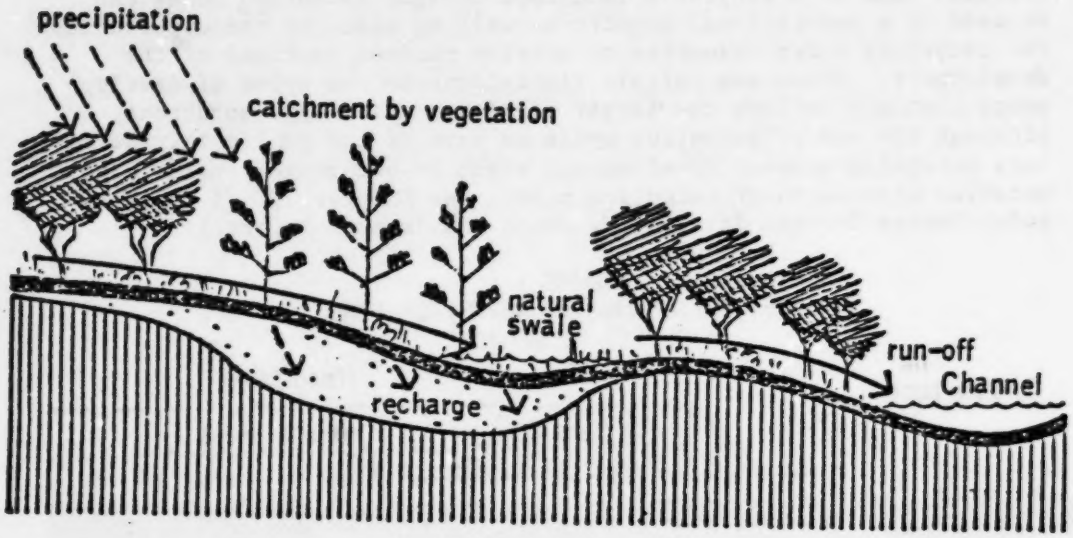



FIGURE 3
NATURAL SWALE

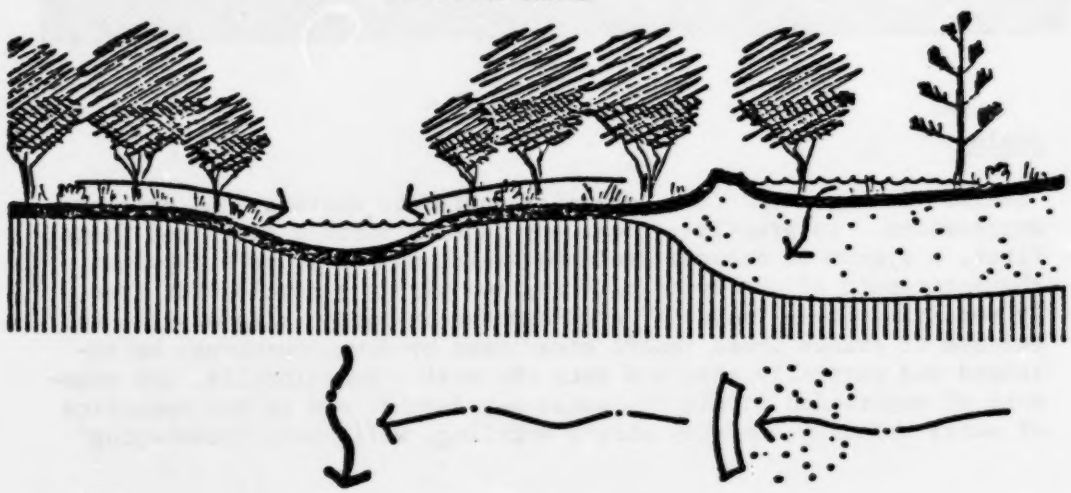
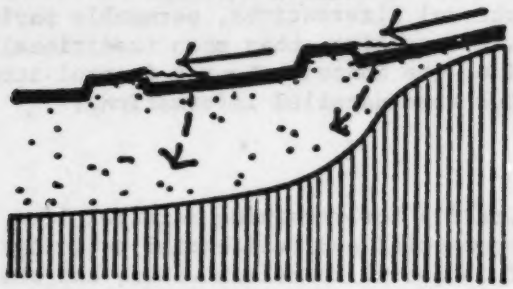


FIGURE 4
CHECK DAM SWALES



Another version of the same basic type of alternative involves the use of swales and check dams in lieu of curbs and gutters as frontage to developed property. At the lot level, swales are feasible, although perhaps less appropriate than swales at larger levels.

Lot Detention Via French Drains

French drains usually incorporate a sand/gravel bed surrounding a matrix of agricultural drainage pipes that act in concert to absorb, detain, and retard release of runoff. The storage capacity of such systems is a function of the effective depth, material filtration capacity and the surface area incorporated into this drainage system. Compaction over time of the sand/gravel bed may tend to limit its storage capacity. Coverage of drained areas with topsoil layers for landscape purposes may further limit the long-term effectiveness of French drains as a drainage system. However, the opportunity exists to incorporate treated areas as part of the overall landscape design. Compared to more traditional landscaping alternatives, such a treatment may be more expensive.

Permeable Pavements, Grasscrete and Humus Enriched Soil

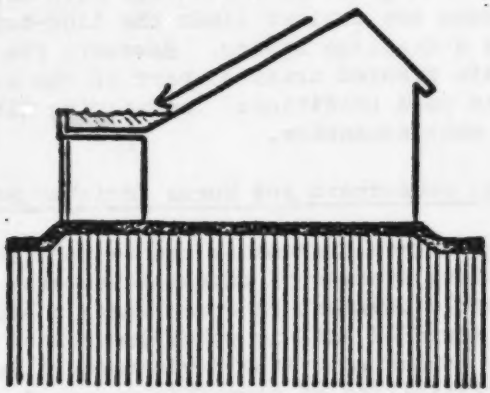
Several alternative surface treatments can be used to absorb runoff by providing subsurface storage of excess stormwater runoff. These would include permeable pavement in areas where a hard surface is required and humus enriched soil in other landscaped areas. Experiments have been conducted by the Environmental Protection Agency that indicate the feasibility of permeable pavement, but the application of this pavement material requires rigorous attention to preparation of the material. Otherwise, the surface may crumble and lose its porosity. The sandy or porous subsurface material must also have drainage outlets, either artificial or natural. A proprietary paving product with similar capabilities is Grasscrete. The use of humus enriched soils increases the latent soil moisture holding

capacity, thereby adding to stormwater storage, albeit somewhat marginally. Although proprietary products such as Grasscrete and the use use of humus enriched soils in landscaped areas may be more expensive than more conventional alternatives, permeable paving is equal in cost, or even less expensive, than more traditional paving materials. (See Chapter VII of the Nonpoint Source Control Strategies, Costs and Impacts report for more detailed information.)

Roof Ponding

A possible alternative for retaining rainfall lies in certain types of flat-roofed commercial and residential buildings. Here, the surface of the roof is sealed to retain water, and the roof structure is reinforced to withstand the higher vertical loading. The perimeter of the ponding surface usually takes the form of a vertical upturn that becomes an integral part of the roofing surface. Drainage via conventional gutter systems and downspouts can be used to convey the water down to the land surface. The ponded water can be used for several practical purposes. These would include storage for central air conditioning plant cooling water, an auxiliary water supply for non-consumptive use, augmentation of fire protection, and thermal insulation. The costs of the roof surface and structure for this alternative are greater than those for conventional flat roof systems, although not prohibitively so. (See Chapter VII of the Nonpoint Control Strategies, Costs and Impacts report for more detailed information.)

FIGURE 5
ROOF TOP STORAGE



# TABLE 1
## COST PER DWELLING UNIT
## ANALYSIS OF
## ALTERNATIVES*

| | | DETENTION VIA GOLF COURSES $0.54/CU.FT. | DETENTION THROUGH AMENITY FOREST (ASSUMES 5 FOOT DEPTH) | NATURAL SWALES AS PART OF NATIONAL OPEN SPACE $0.37/CF | SUBDIVISION LEVEL SWALE DETENTION CATCHMENTS $0.85/CF | SWALES WITH CROSSINGS AS PERIMETER OF PROPERTY $0.58/CF | LOT LEVEL SWALE DETENTION CATCHMENTS $0.51/CF | INDIVIDUAL LOT DETENTION VIA FENCE SWALES WITH CUT DEPTH $0.48/CU.FT. | INDIVIDUAL LOT DETENTION VIA PERIMETER SWALES WITH FILLS $0.48/CU.FT. | SWALE EXCAVATED SOIL $0.82/CY | ROOF PONDING $1.30/CU.FT. | PONDABLE PAVEMENTS $0.12/CU.FT. | CHANNELS $3.15/CY | CONVENTIONAL CURB + GUTTER | CONVENTIONAL RESIDENTIAL STREET | CONVENTIONAL STORM SEWER SYSTEM | CONVENTIONAL DRAINAGE RECTIFICATION SYSTEM - OPEN DITCH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 ACRE | TRACT 1 DU/AC | | | | | | | .22AF $4589/DU | .22AF $4861/DU | .22AF $ 213/DU | .069AF $3096/DU | | .01 AF 792/DU | $ 972/DU | $7913/DU | $2500/DU | $1804/DU |
| | TRACT 4 DU/AC | | | | | | | .20AF $1045/DU | .25AF $1306/DU | .20AF $ 49/DU | .184AF $2597/DU | | .045AF 606/DU | $ 352/DU | $2869/DU | $ 907/DU | $ 451/DU |
| | TRACT 7 DU/AC | | | | | | | .15AF $ 448/DU | .19AF $ 560/DU | .10AF $ 12/DU | .289AF $2337/DU | | .06 AF 525/DU | $ 236/DU | $1921/DU | $ 607/DU | $ 258/DU |
| | FUD 6 DU/AC | | | | | | | .25AF $ 871/DU | .31AF $1089/DU | .26AF $ 19/DU | .206AF $1948/DU | | .052AF 575/DU | $ 115/DU | $ 939/DU | $ 297/DU | $ 301/DU |
| | FUD 10 DU/AC | | | | | | | .15AF $ 313/DU | .19AF $ 391/DU | .11AF $ 10/DU | .345AF $1299/DU | | .08 AF 660/DU | $ 60/DU | $ 608/DU | $ 192/DU | $ 180/DU |
| 100 ACRES | TRACT 1 DU/AC | | 22AF $3430/DU | 5AF $826.56/DU | 3AF $1116/DU | 2.25AF $ 570/DU | 2.25AF $ 300/DU | 22AF $4589/DU | 22AF $4861/DU | 22AF $ 213/DU | 6.90AF $3096/DU | 12.60AF $-480/DU | 1.0 AF 792/DU | $ 972/DU | $7913/DU | $2500/DU | $1804/DU |
| | TRACT 4 DU/AC | | 42AF $1200/DU | 5AF $206.64/DU | 3AF $ 279/DU | 3.25AF $ 176/DU | 3.25AF $ 109/DU | 20AF $1045/DU | 25AF $1306/DU | 20AF $ 49/DU | 18.60AF $2597/DU | 19.95AF $-255/DU | 4.5 AF 606/DU | $ 352/DU | $2869/DU | $ 907/DU | $ 451/DU |
| | TRACT 7 DU/AC | | 48AF $ 773/DU | 5AF $118.08/DU | 3AF $ 160/DU | 2.25AF $81.42/DU | 2.25AF $ 61/DU | 15AF $ 448/DU | 19AF $ 560/DU | 10AF $ 12/DU | 28.98AF $2337/DU | 13.40AF $- 97/DU | 6.0 AF 525/DU | $ 236/DU | $1921/DU | $ 607/DU | $ 258/DU |
| | FUD 6 DU/AC | | 41AF $ 799/DU | 5AF $137.76/DU | 3AF $ 186/DU | 4.25AF $80.63/DU | 4.25AF $35.63/DU | 25AF $ 871/DU | 31AF $1089/DU | 26AF $ 19/DU | 20.6 AF $1948/DU | 31.65AF $-383/DU | 5.2 AF 575/DU | $ 115/DU | $ 939/DU | $ 297/DU | $ 301/DU |
| | FUD 10 DU/AC | | 51AF $ 572/DU | 5AF $ 82.66/DU | 3AF $ 112/DU | 3.75AF $32.30/DU | 3.75AF $18.06/DU | 15AF $ 313/DU | 19AF $ 391/DU | 11AF $ 10/DU | 34.40AF $1299/DU | 25.80AF $-195/DU | 8.0 AF 660/DU | $ 74/DU | $ 608/DU | $ 192/DU | $ 180/DU |
| | FUD 15 DU/AC | | 38.5AF $ 508/DU | 5AF $ 55.10/DU | 3AF $ 74/DU | 3.00AF $53.82/DU | 3.00AF $22.06/DU | | | 24AF $ 19/DU | 41.33AF $1558/DU | 25.80AF $- 91/DU | 8.5 AF 448/DU | $ 71/DU | $ 530/DU | $ 166/DU | $ 120/DU |
| | CONVENTIONAL 20 DU/AC | | 44AF $ 348/DU | 5AF $ 41.33/DU | 3AF $ 56/DU | 2.75AF $32.05/DU | 2.75AF $15.68/DU | | | 6AF $ 3/DU | 36.73AF $1039/DU | 25.80AF $- 68/DU | 8.9 AF 375/DU | $ 98/DU | $ 455/DU | $ 144/DU | $ 90/DU |
| 250 ACRES | TRACT 1 DU/AC | | 95AF $2534/DU | 12.8AF $826.56/DU | 7.5AF $1116/DU | 5.75AF $ 570/DU | 5.75AF $ 300/DU | 95AF $4589/DU | 95AF $4861/DU | 95AF $ 213/DU | 17.22AF $3096/DU | 31.45AF $-480/DU | 2.5 AF 792/DU | $ 972/DU | $7913/DU | $2500/DU | $1804/DU |
| | TRACT 4 DU/AC | | 105AF $1015/DU | 12.8AF $206.64/DU | 7.5AF $ 279/DU | 8.25AF $ 176/DU | 8.25AF $ 109/DU | 50AF $1045/DU | 62.5AF $1306/DU | 50AF $ 49/DU | 45.91AF $2597/DU | 47.00AF $-255/DU | 11.25AF 606/DU | $ 352/DU | $2869/DU | $ 907/DU | $ 451/DU |
| | TRACT 7 DU/AC | | 121AF $ 668/DU | 12.8AF $118.08/DU | 7.5AF $ 160/DU | 5.75AF $81.42/DU | 5.75AF $ 43/DU | 37.5AF $ 448/DU | 47AF $ 560/DU | 25AF $ 12/DU | 72.31AF $2337/DU | 31.65AF $- 97/DU | 15.0 AF 525/DU | $ 236/DU | $1921/DU | $ 607/DU | $ 258/DU |
| | FUD 6 DU/AC | | 103AF $ 677/DU | 12.8AF $137.76/DU | 7.5AF $ 465/DU | 10.75AF $80.63/DU | 10.75AF $35.63/DU | 62.5AF $ 871/DU | 78AF $1089/DU | 66AF $ 19/DU | 51.65AF $1948/DU | 79.20AF $-383/DU | 13.0 AF 575/DU | $ 115/DU | $ 939/DU | $ 297/DU | $ 301/DU |
| | CONVENTIONAL COMBINATION | | 116AF $ 590/DU | 12.8AF $111.70/DU | 7.5AF $ 151/DU | 6.75AF $48.61/DU | 6.75AF $48.05/DU | 37.5AF $ 424/DU | 47AF $ 530/DU | 31.5AF $ 22/DU | 66.34AF $1583/DU | 42.20AF $- 61/DU | 13.5AF $ 465/DU | $ 204/DU | $1679/DU | $ 531/DU | $ 244/DU |
| | FUD COMBINATION | | 112AF $ 476/DU | 12.8AF $ 91.84/DU | 7.5AF $ 124/DU | 9.1AF $53.07/DU | 9.1AF $32.83/DU | 48.8AF $ 453/DU | 70AF $ 366/DU | 40.5AF $ 14/DU | 67.15AF $1568/DU | 52.00AF $- 70/DU | 14.3AF $ 492/DU | $ 83/DU | $ 440/DU | $ 208/DU | $ 194/DU |
| 500 ACRES | TRACT 1 DU/AC | 150AF $3942/DU | 110AF $2151/DU | $826.56/DU | 15AF $1116/DU | 11.25AF $ 570/DU | 11.25AF $ 300/DU | 110AF $4589/DU | 110AF $4861/DU | 110AF $ 213/DU | 34.41AF $3096/DU | 63.38AF $-480/DU | 5.0 AF 792/DU | $ 972/DU | $7913/DU | $2500/DU | $1804/DU |
| | TRACT 4 DU/AC | 150AF $1495.50/DU | 210AF $ 946/DU | 26.07AF $206.64/DU | 15AF $ 294/DU | 16.25AF $ 176/DU | 16.25AF $ 109/DU | 100AF $1045/DU | 125AF $1306/DU | 100AF $ 49/DU | 91.82AF $2597/DU | 95.00AF $-255/DU | 22.5 AF 606/DU | $ 352/DU | $2869/DU | $ 907/DU | $ 451/DU |
| | TRACT 7 DU/AC | 150AF $ 848.85/DU | 241AF $ 494/DU | 26.07AF $118.08/DU | 15AF $ 168/DU | 11.25AF $81.42/DU | 11.25AF $ 43/DU | 75AF $ 448/DU | 94AF $ 560/DU | 50AF $ 12/DU | 144.63AF $2337/DU | 63.38AF $- 97/DU | 30.0 AF 606/DU | $ 236/DU | $1921/DU | $ 607/DU | $ 258/DU |
| | FUD 6 DU/AC | 150AF $ 983.33/DU | 206AF $ 558/DU | 26.07AF $137.76/DU | 15AF $ 196/DU | 21.25AF $80.63/DU | 21.25AF $35.63/DU | 125AF $ 871/DU | 156AF $1089/DU | 130.F $ 19/DU | 103.30AF $1948/DU | 158.42AF $-383/DU | 31.5 AF 575/DU | $ 115/DU | $ 939/DU | $ 297/DU | $ 301/DU |
| | CONVENTIONAL COMBINATION | 150AF $ 902.97/DU | 230AF $ 663/DU | 26.07AF $111.70/DU | 15AF $ 159/DU | 13.75AF $48.11/DU | 13.75AF $48.05/DU | 75AF $ 424/DU | 94AF $ 530/DU | 62.5AF $ 22/DU | 132.68AF $1583/DU | 105.40AF $- 61/DU | 33.0AF $ 465/DU | $ 204/DU | $1679/DU | $ 531/DU | $ 244/DU |
| | FUD COMBINATION | 150AF $ 733.58/DU | 220AF $ 422/DU | 26.07AF $102.04/DU | 15AF $ 142/DU | 18.08AF $58.84/DU | 18.08AF $58.70/DU | 97.5AF $ 503/DU | 140AF $ 629/DU | 81AF $ 14/DU | 134.30AF $1568/DU | 126.60AF $- 70/DU | 35.8AF $ 492/DU | $ 83/DU | $ 440/DU | $ 208/DU | $ 194/DU |

UNIT COST = $\frac{\text{TOTAL COST}}{\text{TOTAL CU.FT.}}$

*SOURCE: Rice University School of Architecture, "Draft Preliminary Analysis of Structural and Non-Structural Flood Control Alternatives for Cypress Creek Texas", a report prepared for the U.S. Army Corps of Engineers, July 4, 1977.

Financial Feasibility

TABLE 2

| | | MECHANISMS/ACRE FEET | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RETENTION VIA GOLF COURSES | RETENTION THROUGH AMENITY PONDS (ASSUME 5 FOOT DEPTH) | NATURAL SWALES AS PART OF RESIDUAL OPEN SPACE | SUBDIVISION LEVEL SWALE DETENTION CATCHMENTS | SWALES WITH CHECKDAMS AS FRONTAGE OF PROPERTY | LOT LEVEL SWALE DETENTION CATCHMENTS | INDIVIDUAL LOT RETENTION VIA FRENCH DRAINS WITH OUT EARTH | INDIVIDUAL LOT RETENTION VIA FRENCH DRAIN WITH EARTH | HUMUS ENRICHED SOIL | ROOF PONDING | PERMEABLE PAVEMENTS | GRASSCRETE | PERCENT OF RUNOFF RETAINED | TOTAL COST/D.U. OF NATURAL SYSTEM | TOTAL COST/D.U. OF COMPARABLE CONVENTIONAL SYSTEM |
| 1 ACRE | TRACT 1 DU/AC | | | | | | | | | .22 | | | | 100% | $ 213 + | $4309 |
| | TRACT 4 DU/AC | | | | | | | .20 | | .20 | | | .045 | 100% | $1397 + | $3320 |
| | TRACT 7 DU/AC | | | | | | | | .19 | .10 | .195 | | | 100% | $2100 + | $2179 |
| | PUD 6 DU/AC | | | | | | | .25 | | .24 | | | | 120% | $ 890 + | $1240 |
| | PUD 10 DU/AC | | | | | | | | .19 | .24 | .21 | | | 100% | $1192 + | $4788 |
| 100 ACRES | TRACT 1 DU/AC | | | 5 | 3 | | 2.25 | | | | | | | 100% | $10,789 | $13,189 |
| | TRACT 4 DU/AC | | 11.8 | 5 | 3 | | 3.25 | | | | | 18.95 | | 100% | $3546 | $4579 |
| | TRACT 7 DU/AC | | | 5 | 3 | | 2.25 | | 19 | | 6 | 12.60 | | 100% | $2712 | $3022 |
| | PUD 6 DU/AC | | | 5 | 3 | | 4.25 | | | 24 | | | 3.25 | 100% | $1675 | $1652 |
| | PUD 10 DU/AC | | | 5 | 3 | | 3.75 | 13.95 | | | | 25.3 | | 100% | $ 976 | $1054 |
| | PUD 15 DU/AC | | | 5 | 3 | | 3.00 | | | 24 | | | 3 | 100% | $ 858 | $ 887 |
| | CONVENTIONAL 20 DU/AC | | | 5 | 3 | | 2.75 | | | | 7.95 | 25.3 | | 100% | $ 725 | $ 745 |
| 250 ACRES | TRACT 1 DU/AC | | | 12.8 | 7.5 | 5.75 | | | | | | 20.95 | | 100% | $9804 | $13,189 |
| | TRACT 4 DU/AC | | 47 | 12.8 | 7.5 | 8.25 | | | | | | 47 | | 100% | $3730 | $4579 |
| | TRACT 7 DU/AC | | 63.3 | 12.8 | 7.5 | 5.75 | | | | | | 31.65 | | 100% | $2532 | $3022 |
| | PUD 6 DU/AC | | | 12.8 | 7.5 | 10.75 | | | | | | 71.95 | | 100% | $1365 | $1652 |
| | CONVENTIONAL COMBINATION | | | 12.8 | 7.5 | 6.75 | | | 47 | | | 42.20 | | 100% | $2460 | $2660 |
| | PUD COMBINATION | | | 12.8 | 7.5 | 9.01 | | | | 29.8 | | 52.80 | | 100% | $ 869 | $1144 |
| 500 ACRES | TRACT 1 DU/AC | | | 26.0 | 15 | | 11.25 | | | | | 57.80 | | 100% | $9535 | $13,189 |
| | TRACT 4 DU/AC | | 153 | 26.0 | 15 | | 16.25 | | | | | | | 100% | $4094 | $4579 |
| | TRACT 7 DU/AC | 150 | | 26.0 | 15 | | 11.25 | | | | | 63.38 | | 109% | $3001 | $3022 |
| | PUD 6 DU/AC | | 12.5 | 26.0 | 15 | | 21.25 | | | | | 158.42 | | 113% | $1059 | $1652 |
| | CONVENTIONAL COMBINATION | 150 | 25.0 | 26.0 | 15 | | 13.75 | | | | | | | 100% | $2852 | $26 |
| | PUD COMBINATION | | 34.4 | 26.0 | 15 | | 18.00 | | | | | 126.60 | | 164% | $ 959 | $1144 |



+=additional costs

## Performance Controls and Proscriptive Controls

Given this range of potential alternatives, an initial option that pervades the "how" analysis concerns the distinction between performance oriented controls and proscriptive controls. Performance controls specify a desired end product expressed in terms of physical and chemical parameters. For example, the drainage system may be required to retain, on site, all of the runoff generated by a 25-year storm event. Or, more specific to nonpoint sources, a developer may be required to demonstrate that his plan, if built, would discharge only "X" lbs/acre of suspended solids as nonpoint sources. These "performance parameters" may be codified in a number of ways, but the principle is the same. The control does not specify the mechanisms to be used at the development level, but only that the developer must demonstrate that those mechanisms he is planning to use will, in fact, produce the specified performance parameters.

By contrast, proscriptive controls specify the use of certain types of processes within the development. For example, an ordinance could be passed requiring all developers to use mulching as an erosion control device. Or, an ordinance could be passed requiring that all developments over 100 acres in size have a 5 acre retention pond. In this manner, the regulation specifies certain features which must be integrated within the development plan.

There are a number of positive and negative aspects of both performance and proscriptive controls. Initially, it must be stated that proscriptive controls are the simplest to administer. Once the determination is made requiring that a particular alternative be used, the permitting authority merely reviews the plans and specifications of the development to determine if the requirements have been met. Little if any technical expertise is required to administer such a program. The weakness of the proscriptive approach lies in its simplicity. By specifying the exact control mechanism, the regulatory system may be totally unresponsive to questions of cost and developer flexibility, as well as the mechanism's effectiveness to varied conditions. In this manner, competition between developments may be limited, and the incentive for developer innovation would be lost.

The performance alternative seems preferable to a developer, but may be difficult to implement and enforce administratively. Unlike the proscriptive approach, the performance approach requires a higher level of staff expertise. Such an approach may consist of a developer bringing a set of plans to the governmental entity specifying the controls he plans to use and showing in engineering terms the effectiveness of the system from the nonpoint source pollutant standpoint. The technical staff must then make an independent analysis of the efficiency of the program, and the staff must determine whether the system will in fact meet the requisite performance guidelines. Since there are a number of

variables that may be altered to control nonpoint sources, a large number of alternatives are potentially available for technical analysis. The strengths of the performance approach, however, lies in the fact that the regulation does not preclude a developer's options. In fact, many cost incentives available to the developer may be utilized in a performance approach. Innovation and cost concern would definitely be the strengths of the performance system.

Therefore, the initial option to be considered in influencing "how" development occurs would be a determination of whether a proscriptive or performance type of system is desired. Once this decision is made, a determination must be made concerning the proper legal mechanism for implementing such a system. The primary source of legal authority exists in governmental controls. The section which follows describes the regulatory alternatives applicable to either performance of proscriptive types of controls.

## Controls For Influencing "How" Development Occurs

Three general types of regulatory controls are exercised at the local governmental level. These are zoning, subdivision plat approval, and building permits. These three control types are not mutually exclusive; in fact, they are quite complementary. They may be viewed as differing levels of regulation. Zoning is generally concerned with relatively large areas in a spatial sense. Although zoning ordinances can be quite specific, they generally have the least spatial resolution. Subdivision plat approval is the next level of regulatory resolution; street, drainage, and general land use layouts are usually specified for this review. Building codes and permits are applicable on a lot by lot basis, thereby offering the highest degree of spatial resolution. Together, these three control types offer a general range of controls for initial consideration.

### Zoning

The applicability of zoning to the "how" of land development is more complex than the applicability of zoning to the "where" of land development. In particular, the zoning classification must be tightly tied to the technical understanding of the nonpoint source pollution problem. The usual zoning classifications, such as single family or multifamily, could be useful due to variations in volume and type of pollutants. However, a potential application of the zoning system may be in terms of the performance standard concept where areas were zoned with respect to the desired level of performance (performance zoning). In other words, rather than being zoned at single family, 4 dwelling units per acre, an acre might be zoned as nonpoint source category 2, which would correspond to a predetermined performance parameter(s). In this manner, an overall vehicle would exist to forward the performance concept.

However, this application of zoning may not be necessary. The level of resolution offered by zoning in this instance may be less than is desirable, and alternative legal mechanisms exist that may, in fact, offer the same degree of control without necessitating the development of an elaborate zoning system. The prospect of using zoning to forward such a nonpoint source control system is best where an existing zoning framework has been established. The variation of the system for nonpoint source control can be accomplished primarily through the use of such mechanisms as Planned Unit Developments rather than the more traditional classifications. In other words, the traditional zoning system may achieve certain social goals, but be unresponsive to the nonpoint source control problem. Alternatives such as Planned Unit Developments offer flexibility in terms of the mix of development types and open space necessary to achieve an overall nonpoint source control program. If no zoning system is in existence within the watersheds of concern, an entire regulatory program influencing "how" land development occurs may be implemented using subdivision plat approval and building permit processes. Therefore, while zoning may be used in influencing how development takes place, its applicability is more important relative to "where". Secondly, an existing zoning program may actually limit performance oriented alternatives, and the presence of an existing system would need to be analyzed to determine its effect, if any, on a desired alternative approach.

In Texas, there are limitations upon the ability of local governments to establish zoning programs. Local governments have only those powers specifically given by the State Legislature, and only municipalities have been given power to zone in Texas. Further, this zoning authority is limited to land within municipal limits; areas of extraterritorial jurisdiction may not be zoned. Therefore, an area such as the Houston 208 designated area has much of its land not subject to zoning authority by any level of government. Although several of the small municipal jurisdictions in the 208 area have zoning porgrams in effect, the City of Houston, which comprises a large portion of the 208 area, does not.

Subdivision Plat Approval

A second form of governmental control may be found in the approval by local governments of subdivision plats prior to the construction of such subdivisions. These subdivision plats define the general layout of the subdivision both conceptually and at a more detailed level. Subdivision plats generally include information about the transportation and circulation system, the drainage system, the general land use plan, the water system, and the sewer system. As such, many of the potential variables for nonpoint source control are identified and reviewed in the subdivision plat approval process. A nonpoint source control program centering upon the subdivision plat approval process may be quite feasible.

The distinction between performance and proscriptive approaches will appear most directly at the subdivision plat approval level. Although either approach may be workable, the major distinction between the two would appear in the mechanics of the subdivision plat approval ordinance. If a performance approach were adopted, the ordinance would be phrased in terms of review parameters regarding volume and quality of stormwater flowing from the site. The applicant would be required to develop documentation regarding the engineering specifications and the design criteria that led to the proposal of a particular system. If a proscriptive approach were chosen, then the ordinance would be phrased in terms of the specific alternatives which the governmental system required. For example, the ordinance may require that retention ponds be required on a predetermined ratio basis (i.e., 5 retention pond acres for each 100 acres of developed land) or the ordinance may require that several alternatives mentioned in earlier sections be used. The important point at this stage of the analysis, however, is that either a performance oriented or a proscriptive approach may be implemented using the subdivision plat approval process.

In contrast to zoning, subdivision plat approval powers are more generally available to local governmental levels. Municipalities have the power to pass such ordinances for application within their municipal boundaries; they also may make their ordinances applicable to their extraterritorial jurisdictions if specifically stated. At this time, the City of Houston is reviewing subdivision plats in both the extraterritorial jurisdiction and within the city limits, although an ordinance has not been formally approved.

The powers of Texas counties to review subdivision plats are much more limited than that of cities, but counties may review subdivision plats with respect to drainage and transportation plans. Therefore, the major subject area in a county-enforced program would have to be the drainage system, which is certainly related to the control of nonpoint sources of pollution. The compatibility between certain nonpoint source control alternatives and flood plain management is quite good, and this approach might use the plat approval process to address both problems (flooding and nonpoint sources) at the same time.

The Texas Attorney General's office recently issued an opinion invalidating County Flood Control programs passed after June 30, 1970. To remedy this situation, the Texas Legislature passed House Bill 11 during special session. This bill renewed the grant of powers to counties (and other levels of government) to enact flood control programs.

Although the type of flood plain management program generally

applied in Texas is at the building permit level with respect to slab elevation, authority exists to require flood control at the subdivision level relative to downstream areas. In other words, control of runoff at the subdivision level is a flood plain management option that may be implemented to minimize variations in the flood elevations occuring downstream. Documentation is being developed to support the expansion of flood control to the generation of runoff at the subdivision level, thereby protecting landowners who build in conformance to established flood plain elevations. Therefore, the compatibility of the flood control and nonpoint source alternatives is substantial, occurring at both the technical and legal implementation authority level.

If such an approach were undertaken, certain institutional problems would have to be overcome. In particular, the major thrust of an integrated flood control/nonpoint source control strategy would be to slow the movement of water from a subdivision. In this manner, the runoff generated is allowed to enter a major drainage artery more slowly. By slowing the rate of water movement, sedimentation may occur. At the same time, the impact of the runoff upon stream flood flows would be less because the runoff generated would be entering the waterway over a longer period of time, thereby minimizing the impact upon peak flows and flooding. Unfortunately, the existing regulatory system traditionally has encouraged the use of storm sewers that expedite the flow of water from a subdivision.

At the present time, a developer may receive compensation from bond proceeds for expenses incurred in all aspects of drainage system construction except for land requirements. In other words, the developer must donate all land to the utility district that is required to implement a drainage solution. Unfortunately, most alternatives designed to slow the movement of water from a subdivision are land consumptive. This land consumptive aspect means that a major portion of the costs associated with constructing such a system must be paid by the developer from his own funds without compensation from a bond issue. As set forth in Tables 1 and 2, the overall costs of either a storm sewer system or a retention-type system are approximately the same. However, given this limitation upon the use of bond proceeds, the developer's financial pro forma and cash outlay will be affected differently by the retention system. It should be noted that the Texas Water Rights Commission has the authority to alter these rules and regulations if they could be convinced of the desirability of such a change.

Building Permit Level

The third level of regulatory control is at the individual dwelling or lot level. Most municipalities (Houston included) have passed

ordinances controlling the types of materials as well as other aspects of building construction. These programs have often included the flood plain management criteria of building slab elevation in addition to the more traditional, building materials orientation of building code ordinances. These ordinances are manifested by the requirement that the lot owner obtain a permit from the city before commencing construction. Further, the city generally checks to make sure that permit specifications were met prior to issuing a permit allowing electrical service to be turned on at the building. This building permit system offers a very high degree of regulatory resolution, and certain nonpoint source control alternatives may be implemented at the building permit level. These alternatives, however, must generally be proscriptive rather than performance type of controls if the building permit process is to be relied upon alone. Although a building permit process could be performance-oriented, the number of options for meeting performance criteria solely at the lot level are limited.

The control options suitable for a nonpoint source control program at the lot level involve limitations in the amount or percentage of the lot that may be cleared or covered with impermeable surfaces, roof top storage of stormwater, and perhaps the specification of erosion controls to be used on a lot by lot basis. While these and other opitons may be part of a performance "package" implemented by a developer, the performance control must be administered at a regulatory level encompassing larger land areas. However, if certain controls at the lot level are proscribed, the building permit process offers an implementation mechanism.

Theoretically, the subdivision plat approval process and the building permit process should be thoroughly integrated. These two processes are highly complementary, and a better program would ensue from their integration, regardless of whether the approach were performance or proscriptive. For example, a performance approach would initially be implemented at the subdivision plat review level. At this time, the developer would present an overall plan for controlling nonpoint sources. This plan may include retention ponds, natural drainage and limitations upon the amount of land area to be cleared for the dwellings within the subdivision. If the overall plan is accepted, the retention pond and the natural drainage system would be implemented through the formal recordation of the plat with the governmental entity. However, the specifications relative to clearing on a lot by lot basis could be monitored through the building permit process. In other words, once the developer selects his performance system, the building permit process would offer the mechanism for determining if the plan were implemented according to the specifications submitted. If not, then an electrical connection would not be allowed, for example. Similarly, if a proscriptive approach were

pursued, the governmental entity may require certain controls to be monitored at the subdivision plat level (i.e., retention ponds) and others to be monitored at the building permit level (i.e., limits upon the amount of devegetation). Therefore, the subdivision plat approval process and the building permit process may be integrated in an overall nonpoint source control program, whether it be proscriptive or performance in nature.

Texas cities have the power to pass ordinances establishing building codes and permit procedures, but this authority does not extend to their areas of extraterritorial jursidiction. Counties and other governmental bodies have passed building ordinances relative to slab elevation for flood control purposes. Those counties with a legal, flood-related building permit process could require certain flood control/nonpoint source control programs to be implemented at the building permit level. For example, a program limiting impermeable surface may be related to both the generation of nonpoint sources and to the generation of additional flood waters due to development. Such a program may be within the powers of counties to establish flood plain management programs, although this premise is untested. If existing legal authority is construed as a limitation in a nonpoint source control program, the application of the building permit process in unincorporated areas must be related to flood plain management in counties.

Septic Tank Regulation

Additional authority exists in counties with respect to septic tanks. Septic tanks, of course, can be a major contributor to nonpoint source pollution if they are improperly designed or used where soil conditions do not allow proper infiltration. This power to control septic tanks is enforced at the building permit level, but is limited strictly to the subject matter of private disposal systems. If a county desires to exercise this control, an order to that effect must be issued by the Texas Water Quality Board. To the extent that such controls are found to be necessary, substantial power exists at the county level to enforce such a program. Again, the option exists for such a program to be either performance or proscriptive oriented. Generally, Texas Water Quality Board Orders restricting septic tanks have been of a proscriptive nature, limiting septic tank densities to a certain number per acre.

## Site Level Erosion Controls

The primary function of the following alternatives for nonpoint source control is the reduction of pollutant loading factors (primarily suspended solids) associated with various land use activities. As such, these controls are concerned with reducing the potential for nonpoint source pollution by limiting either the

land area exposed during construction activity or by stabilizing exposed soil. In either case, these alternatives may be considered independently from subdivision level controls (such as retention, ponding, etc.) and will generally provide nonpoint source control only during the construction phase. It should be noted that these controls again may be either proscriptive or performance oriented.

Management of Site Construction Activity

The primary thrust of this alternative is directed towards the phasing of construction activity, the storage site work equipment and supplies, and the limitation of the total amount of devegetation. One of the greatest sources of suspended solids loads comes as a consequence of sheet erosion of an exposed construction site. All other things being equal, the two major factors influencing sheet erosion from construction activity are the size of the construction increment (land area exposed) and the time of the construction period (time the land is exposed). As such, the land area exposed at one time during site construction activity should be kept to a minimum. This would include control over devegetated area set aside for site offices, storage of equipment and supplies, etc., as well as the land area of the facility itself. Consideration should also be given to the size (land area) of a construction increment in conjunction with the construction period.

An indication of the potential effectiveness of such controls may be ascertained with application of the Universal Soil Loss Equation. This equation generally takes the form of A = R K LS C P, with the results being expressed in terms of tons of soil loss per acre per year. This formula may be modified to the following form to determine soil loss during construction:

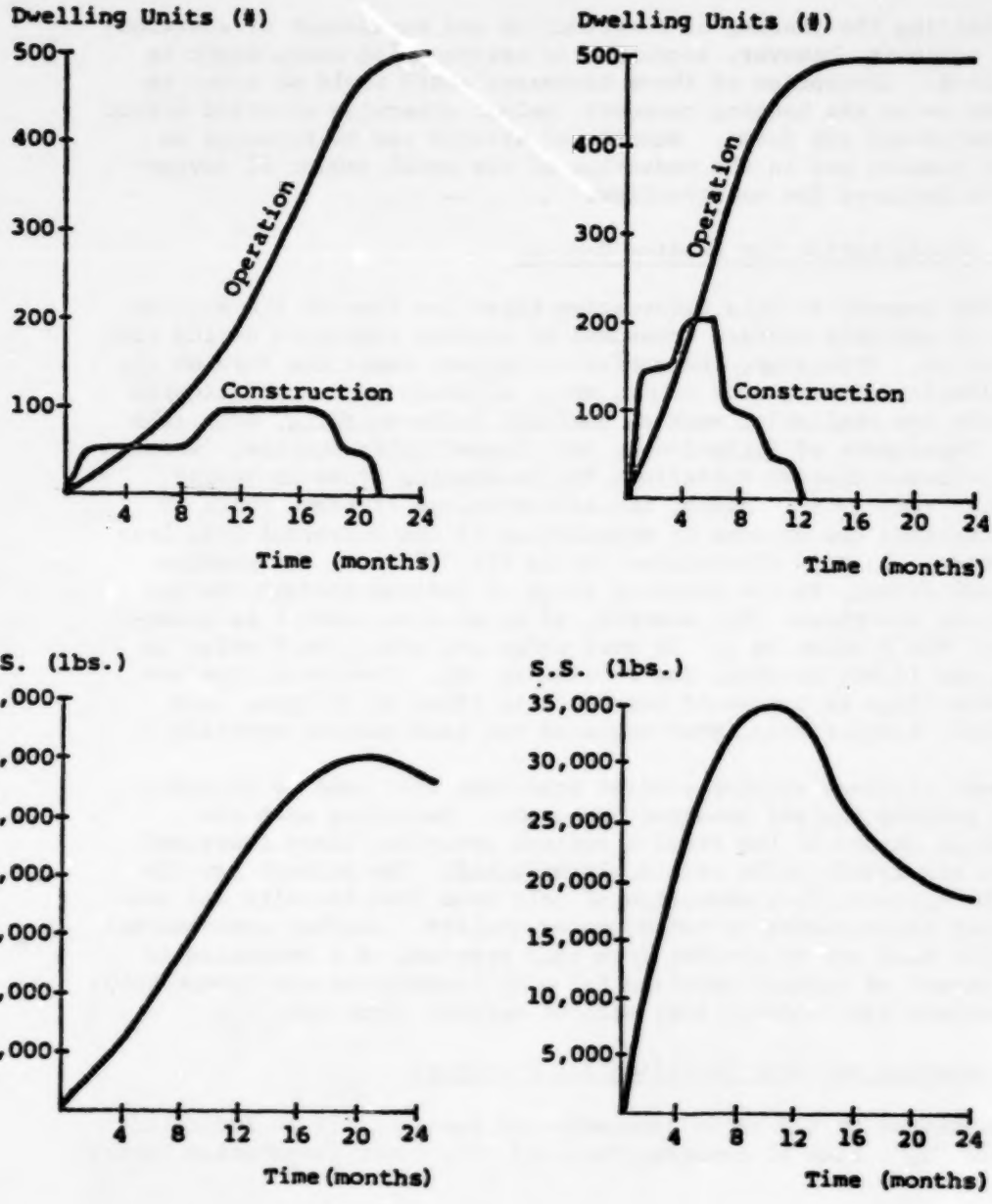
$$A = R\ K\ LS\ C\ P\ (2000/365)\ (T_c)\ (Area)$$ where

A = soil loss in pounds for the construction period
R = rainfall factor (invariant throughout the 208 area)
K = soil erodibility factor
LS = slope length factor
C = cover (vegetation) factor
P = erosion control factor (unity if no erosion controls)
2000/365 = conversion factor to pounds per day
$T_c$ = time of construction in days
Area = area under construction in acres

As can be seen from this formula, the amount of soil loss is a direct function of the time of construction ($T_c$) and the area of the site exposed (area). For illustrative purposes, a hypothetical example of the relationship between expected soil loss and size and timing of construction is shown in Figure 2. (See Chapter IV of

the Assessment of Nonpoint Sources for more detail concerning water pollution from construction activity within the 208 area.)

FIGURE 6
DIAGRAMMATIC ILLUSTRATION OF THE EFFECTS OF DIFFERENCES IN DEVELOPMENT CONSTRUCTION PHASING ON SUSPENDED SOLIDS LOADS



As one can see by these figures, a longer period of construction will generate in a slightly smaller amount of suspended solids being generated at the peak period, even though this peak may be of longer duration. A shorter construction period will result in more suspended solids being generated at the height of the activity, but the duration of that period may be shorter. The option chosen would depend upon the desired results.

By altering the phasing of construction and management of construction activity, however, increases in construction costs might be expected. Absorption of these increased costs would no doubt be passed on to the housing consumer, unless otherwise absorbed within a development pro forma. Beneficial effects can be expected in water quality and in the reduction of the total amount of devegetation required for construction.

Soil Stabilization for Erosion Control

Erosion control in this alternative takes the form of the application of suitable surface treatment of exposed land area during construction. Typically, the surface treatment takes the form of the application of hay, wood chips, etc., although more sophisticated methods are available, such as matting, hydro-mulching, etc. (see U.S. Department of Agriculture, Soil Conservation Service, "Erosion and Sediment Control Guidelines for Developing Areas in Texas", Temple, SCS, 1976). Again, the effectiveness of these types of alternatives can be seen by application of the Universal Soil Loss Equation. In this alternative, it is the "P" term, the erosion control factor, in the equation which is reduced through the use of these practices. For example, if no erosion control is undertaken, the P value is 1. If wood chips are used, the P value is .06, and if hay is used, the P value is .02. Therefore, the use of wood chips or hay would result in 16 times or 50 times less erosion, respectively, than would be the case without controls.

Pursuit of these erosion control practices will tend to increase site preparation and construction costs. Depending upon the specific nature of the erosion control practice, these increased costs are likely to be relatively marginal. The primary benefit of the approach is a reduction of soil lost from the site and consequent improvements in runoff water quality. Another concommitant benefit that may be derived from this approach is a reduction in the amount of topsoil required for site landscaping and revegetation to replace that topsoil lost without erosion controls.

Revegetation and Site Rectification Practices

As suggested by the above arguments and particularly as indicated by the "$T_c$", time of construction, and "C", cover (vegetation factor),

terms from the modified soil loss equation, soil loss, and suspended solids loads are very much a function of the type and timeliness of site revegetation. Extensive research has been completed by the Soil Conservation Service (SCS) and other agencies regarding suitable (fast-growing) cover materials for different landscape applications. The local SCS office can provide detailed information regarding costs of revegetation as well as information concerning the most suitable vegetation types for various soil types, seasons, and applications. The benefits are generally as described in the previous section.

Site Design

Hydrologic literature indicates that total volume and rates of runoff are very much a function of the amount of impermeable surface within a subwatershed. Within urban areas, the major contribution to the amount of impermeable surface is the land area that is paved or occupied by buildings. Site design that attempts to reduce the total amount of area rendered impermeable should be pursued. Alternatives such as cluster housing, planned unit developments, and similar types of residential and commercial land use configurations may render less of a site impermeable while holding the number of units constant. Pursuit of this type of strategy can also have the effect of reducing the total amount of devegetation (see discussion above), thereby allowing a greater amount of rainfall to be intercepted. Another aspect of site design seeking to minimize runoff is the location of impermeable surfaces on the most impermeable natural substrate conditions of the site. However, in areas such as much of the 208 area, where soils are relatively impermeable over large areas, the strategy may have limited applicability.

A potential impediment to the pursuit of site design as a nonpoint source control strategy concerns the marketability of the resultant housing unit. While there is a definite preference for the "tract house" within the 208 area, rising construction and land acquisition costs are tending to increase the marketability of single-family attached (i.e., townhouse) dwellings. Developers often realize savings in the amount of infrastructure investment required by these cluster housing and planned unit alternatives due to reductions in the length of roads, utility lines, etc. (all other things being equal). Environmental benefits are gained by a reduction in the total amount of runoff and a reduction in the areas required to be devegetated. Common open space amenity is also often a feature of such schemes.

Runoff Tax

Another alternative that may indirectly affect the form of land development activities is a runoff tax, or "effluent charge". The

rationale for undertaking such a system would be a tax imposed for the generation of nonpoint source pollution. In this manner, the costs borne by the public at large (i.e., reduced quality of the water) would be limited to the land development activity.

The internalization of "externalities" has long been considered a basic reason for the passage of environmental laws. In fact, the adoption of nonpoint source controls is a mechanism for causing this internalization to occur. However, the runoff tax is the most direct method for bringing about this internalization. The major shortcoming of this approach is that it does not aid in the improvement of the quality of the stream; it only assesses a charge for the pollution.

If the runoff tax were set high enough, the land owner would have a choice with respect to nonpoint source control. If the landowner did not want to undertake nonpoint source controls, the landowner could simply pay the tax. If, however, certain control mechanisms were less expensive than the runoff tax, the landowner could voluntarily utilize certain land development practices and avoid paying the tax. In this manner, a runoff tax could be considered to be an incentive for nonpoint source control if the tax were established at a level higher than the cost of implementing other alternatives.

Due to limitations in the taxing capabilities of various levels of government, only municipalities could pass runoff tax ordinances. More detailed examination of other jurisdictions would be required in order to assess their abilities to tax runoff. Therefore, while limitations do exist with regard to the implementation of runoff taxes, a runoff tax is an approach that may be appropriate in an overall nonpoint source control strategy.

## INTEGRATED LOCATION AND FORM STRATEGIES

At this point, it should be noted that certain of the control strategies identified as influencing "where" development occurs may also be used in the context of "how" development occurs. For example, if a natural drainage system were a desired alternative, such a system could be implemented at a master drainage plan level (i.e., within the entire watershed). In this case, either a fee simple or easement purchase may be made, either on a willing buyer/willing seller basis or through the use of condemnation powers. In this manner, a drainage plan could be developed at public expense that controlled nonpoint source pollution (and perhaps downstream flooding). This alternative would alleviate some of the financing problems alluded to earlier and would be an item of the development infrastructure much like a sewage treatment system. An overall drainage system would exist, and the developer would be required to

meet certain design criteria relative to the capacities of this system with regard to flow. Although such a system could influence where development occurred, the use contemplated by this example is not concerned with influencing the location of development. Instead, this example is concerned with forwarding the "how" of development by providing drainage infrastructure.

Another potential device for controlling nonpoint source pollution would be concerned with influencing the "when" of development as well as the "how". In concept, this approach would be similar to the "time controlled-sequential development" plan of Ramapo, New York. This program limited the demand for public services caused by development through a master plan for the provision of infrastructure. Development could not occur until a certain number of points were available to the subject property, although the schedule could be accelerated by the developer if he provided the necessary public improvements. Although the applicability of this concept seems tangential to nonpoint source control, this alternative may be of importance regarding erosion control, for example.

More generally, the important point is that, once a control strategy has been identified, the implementation of the system could involve any number of governmental powers. Although this presentation rather rigorously divides the techniques into those influencing "how" and "where" development occurs, a substantial amount of overlap may actually exist. The most desirable final plan for the control of nonpoint sources may, in fact, be one that makes use of many types of governmental powers, thereby maximizing the flexibility of the program.

## NONREGULATORY/COOPERATIVE PROGRAMS

There are several alternatives deserving mention that may be implemented at the neighborhood level on a cooperative, nonregulatory basis. These alternatives may be generally grouped under "good housekeeping" techniques. The major implementing entity would be a civic association or perhaps the municipality, depending upon the location of the development and the structure of the deed restrictions. These activities may be the only nonstructural control options that are available in areas that already have been developed.

One alternative at this level concerns the removal of pollutants prior to their being picked up by rainfall runoff. Street sweeping is one approach to this problem area. Another approach might be a leash law for household pets, including a requirement that animal wastes be gathered by the owners and properly disposed. Similarly, good refuse collection programs would aid in the removal of potential pollutants from streets, yards, and neighborhoods generally.

Although street sweeping is an alternative to be implemented by a unit of local government, proper bagging and removal of trash from yards is very much a cooperative effort at the local level. For more information regarding street sweeping, see Chapter VII of the Control Strategies, Costs and Impacts report.

Another level of potential pollution reduction would exist at the local garden club/civic club level. The major thrust of this approach would be to disseminate information concerning the use of pesticides and fertilizers. Information could be provided concerning preferred pesticides, proper dosages of pesticides and fertilizers, as well as information concerning biological control mechanisms. The intent of these alternatives would be to reduce the overall use of these materials in urbanized areas and to eliminate the overuse of them relative to the problem being attacked. In many cases, persons enjoying yards and gardening would be receptive to such information if it could be provided in a straightforward and informative manner.

There are undoubtedly many other alternatives that could be implemented on a cooperative basis at the neighborhood level. The important point is that these controls may be particularly useful in existing urbanized areas where many of the controls mentioned previously are not viable due to the fact that the subdivision is already built. It is difficult to evaluate the effectiveness of these alternatives, but some improvement in the quality of stormwater runoff should result from the use of these "good housekeeping" approaches.

## CONTROL OF AGRICULTURALLY-GENERATED NONPOINT SOURCE POLLUTION

One of the land use types that must be analyzed for potential control of nonpoint source pollution is agricultural land use. There are several types of pollutants that may be produced by agricultural sources, including sediment, nutrients, and pesticides. Depending upon the type of crop, soil conditions, slope, and agricultural management practices being used in a particular area, the production of nonpoint sources of pollution will vary.

Soil loss thorugh erosion appears to be the major nonpoint source problem related to agriculture. The rationale for this statement is two-fold. First, sediment is lost during storm events, directly adding to the suspended solids levels in streams. Second, pesticides, and to a lesser degree, nutrients, adsorb to sediment particles. In this manner, sediment is the major mechanism for the introduction of other chemicals into streams draining agricultural lands.

Erosion controls of various kinds and types have been used in

agriculture for some time. The basic rationale is an economic one -- the loss of soil will eventually lead to a loss of the farm, so to speak, and millions of pounds of valuable topsoil are lost to erosion every year. Although mechanisms for control of erosion are important in the context of overall strategies for nonpoint source control, this aspect is more than adequately documented in Chapter VII of the "Control Strategies, Costs and Impacts" report from the Section 208 planning process. Instead, the major focus of this analysis is upon the institutional aspect of nonpoint source control.

Most of the western portion of the Houston 208 Area is composed of agricultural land. In particular, over 31,000 acres of rice and 30,700 acres of soybeans were harvested in Harris County in 1973. However, the total number of acres devoted to agricultural land uses were much higher in 1973, due to the fact that rice land generally lies fallow for two years and is farmed for one. In this manner, the soil may be used for rice as a renewable resource, rather than being depleted and abandoned. During the fallow cycle, cover crops are allowed to grow through rice stubble, and grazing of cattle in these areas is common. Over 76,000 head of cattle were reported for Harris County in 1973. Ft. Bend, Waller, and Brazoria Counties are also substantial agricultural production areas, with Ft. Bend County being one of the eight most productive counties along the Texas Gulf Coast. In short, a substantial land base is devoted to agricultural land uses in the Greater Houston 208 Area.

A substantial amount of data has been developed about the volumes and types of agricultural nonpoint source pollution to date during the Houston 208 program. Although the final determination of the severity of the problem has not been made, indications are that agricultural land uses are less of a nonpoint source probem than are developed residential and commercial land uses. In other words, the conversion of agricultural land to other uses, such as commercial and residential, may cause a more significant nonpoint source pollution problem than is currently evidenced from agricultural land uses. Therefore, an initial option applicable to nonpoint sources generally would be to attempt to maintain the agricultural land base in the Greater Houston 208 Area.

## Preservation of Agricultural Lands

In order to implement such a policy, those alternatives presented in Section II, influencing "where" development occurs, would be relevant in the context of the preservation of agricultural land areas. In particular, alternatives involving taxation policies, easement acquisition, and infrastructure placement would appear to be most applicable to the question of agricultural lands being converted to other land use types.

## Tax Policies

Taxation policies affect the distribution of land uses in the following manner. As land development activity spreads from the city into the suburbs, the price of the land increases, oftentimes dramatically. Land speculators purchase undeveloped land at prices beyond the ability of the land to economically support agricultural uses. In this manner, the market value of the land quickly passes the value of the land for agricultural purposes. Since most taxation systems are established on market value rather than use value, assessed land values rise throughout areas affected by land speculation.

The problem arises when a farmer is not interested in selling his land; yet the "market value" of his land increases with speculative land development activities. In this manner, the taxes on the land are increased, even though the agricultural production and overall income from the land are not increased. Depending upon the rate of speculative land development, the increase in taxes for agricultural lands may be substantial. For example, in Northwest Harris County, school taxes rose from just $12 an acre in 1969 to a 1974 cost of just over $54 per acre, a 450% increase in five years. This example is not limited to Northwest Harris County; it is more generally the rule throughout the Houston 208 Area.

Of course, there are two sides to this issue. Farmers on the one hand complain about these taxes, and on the other hand many wish to sell their land at these higher, market values. Therefore, from a taxation standpoint, a governmental jurisdiction with taxing power is faced by a dilemna of sorts. If the jurisdiction allows "use value" taxation, then the landowner may reap the benefits of lower taxes and sell to realize the high market values. If the jurisdiction taxes the land at "market value", it may force certain landowners into a position of having to sell the land to pay the higher taxes.

Mechanisms exist to solve the dilemna. At this time, Section 1-d, Article 8, of the Texas Constitution allows a landowner to apply for a "use" value taxation system, rather than a "market" value taxation system. In order to take advantage of this system, the landowner must make a timely application to the taxing jurisdictions for such a classification, and the applicant must show that the agricultural use of the land is the business constituting the primary source of occupation and income. The elements of proof required in such procedings are discussed in the recent case of Gragg v. Cayuga Ind. School District, 19 Tex. Sup. Ct. J. 347 (June 16, 1976). A potential problem with this constitutional provision exists in the income provisions that are a prerequisite for a qualification for the " use value" classification. This

limitation reduces the total amount of land, prime or otherwise, that may qualify for the exemption. However, if land is placed under these constitutional provisions and is subsequently sold, provisions exist for collecting back taxes for three years at market value. Therefore, this provision does begin to offer some aid for a landowner wishing to retain agricultural land and does address the question of a subsequent market value sale.

Development Rights Easements

A second alternative would be that of selling "development rights" to farm land to some level of government. This would most likely take the form of a negative servitude on the land, and it would serve to limit the amount of land converted to residential and commercial uses. However, the use of this mechanism may be limited by the willingness of a local governmental entity to spend public money for such purposes.

Infrastructure Siting

The third approach would involve control of infrastructure siting. As set forth earlier, the provision of certain services expedites development within the service areas of the utilities provided. By locating utilities (i.e., extension of sewage services), in areas that are not currently being used for agricultural purposes, the location of land development could be influenced to a substantial degree. This alternative could be an effective, indirect control device to preserve agricultural lands, and the subject matter is one with which the 208 process is concerned.

## Governmental Control of Nonpoint Source Pollution from Agriculture

Although agricultural land uses produce less nonpoint source pollution than other land use types, some pollution is, of course, generated. Therefore, an examination of regulatory controls applicable to nonpoint source reduction in agricultural lands will be briefly examined. More detail on the structural measures for agricultural nonpoint sources can be found in Chapter VII of the "Control Strategies, Costs and Impacts for Nonpoint Sources" report.

Proposed EPA Program

EPA has proposed, pursuant to the decision of the Federal District Court in the case of NRDC vs. Train, 396 F. Supp. 1393, 7 ERC 1881 (DDC, 1975), the expansion of the National Pollutant Discharge Elimination System (NPDES) permitting process to include discharges from agricultural point sources. These point sources have been

defined as conveyances carrying surface irrigation return flow as a result of the controlled application of water to land used primarily for crops, 42 Fed. Reg. 6846 (February 4, 1977). Although the final form of controls applicable to agricultural lands is not clear at this time, the proposed rules clearly indicate that EPA is considering requiring "best management practice" controls in lieu of "end of pipe" requirements. These proposed rules specifically mention the Section 208 planning process, and the incorporation of locally developed best management practices into the agricultural return flow point source discharge permit. In other words, the nonpoint source and the point source controls would be the same with respect to agricultural sources. Implementation will be effected through a variation of the NPDES permit process whereby general areas are permitted.

National and Local Soil Erosion Programs

A second major point regarding agricultural erosion control is the ongoing role of the Soil Conservation Service of the United States Department of Agriculture and local Soil and Water Conservation Districts. Together, these two organizations have been working for years to help farmers reduce erosion from farmlands. At this time, participation in these programs is totally voluntary, and many area farmers have participated in various programs sponsored by these two agencies. The possibility exists that these programs could be expanded, adding to incentives for participation. Additionally, if either of these alternatives were considered desirable, legislative action would be required.

Relationship to Harris-Galveston Costal Subsidence District

Finally, it should be noted that area rice farmers use water as a herbicide, pumping groundwater over seedlings to reduce the growth of undesirable vegetation. In this manner, the use of chemicals is reduced, thereby reducing the presence of herbicides in runoff from these lands. At this time, the use of groundwater is regulated by the Harris-Galveston Coastal Subsidence District. The rate structure approved by the district currently requires the same fee from area rice farmers as it does from industrial users. This raises the possibility that it may be desirable to reduce the payments required from agricultural uses of groundwater in order to offer an inducement to the use of water as a herbicide. This possibility must, of course, be considered in light of many other factors, including the relationship of such water withdrawals to land surface subsidence in the Houston-Galveston Area. Nonetheless, an institutional opportunity may be said to exist with regard to an ongoing program of one agency possibly forwarding a goal of another agency's program.

## Conclusion

It should be noted that two major alternatives appear important in the context of agricultural nonpoint source control in the Greater Houston 208 Area. First, programs encouraging preservation of the agricultural land base may be viable in the context of an overall program to control nonpoint sources. Secondly, erosion contrcls enforced locally and included in the "general permit" NPDES program, in conjunction with the SCS and Soil and Water Conservation Districts, appear to be the primary controls required for nonpoint source abatement from agricultural lands. The use of these two measures provide two quite different, yet effective, measures for control of agricultural nonpoint sources.

As mentioned in the agricultural control , EPA has recently proposed regulations governing the "general permit" program. This program expands the NPDES permit system to not only agricultural irrigation return flows but also to separate storm sewers. The program as proposed is quite different from the existing NPDES permit program which is reliant upon "end-of-pipe" (technological) treatment of wastewater. In particular, proposed regulations of February 4, 1977, contemplate that general permit program areas (GPPA's) would be designated as geographic area (preferably coincident with designated Section 208 planning areas), and that a single NPDES permit for nonpoint sources would be issued for the entire "GPPA".

Under the proposed regulations, the terms and conditions of the "general permit" would vary from area to area, but the basic structure of these conditions would be to rely upon "best management practices" developed under the Section 208 planning process. According to these proposed regulations:

> "This (general permit) program specifically recognizes that pollution reduction from sources in these categories is often more effectively achieved by using best management practices (BMP's) than by applying end-of-pipe pollution control technology. BMP's are management techniques that reduce the amount of pollutants at their source rather than remove them from their point of discharge into navigable waters."

In other words, the type of control contemplated by these regulations are those controls that have been discussed in the preceeding sections of this nonpoint source addendum.

The importance of the nonpoint source controls developed by the local 208 planning agency must be emphasized. In particular, the possibility exists that the expense and administrative gymnastics of individual permits for these agricultural and storm sewer sources may be avoided if the 208 planning entity tailors a nonpoint source abatement program involving local governmental controls to solve local nonpoint source problems. In this respect, the following quotations from the proposed regulations of February 4, 1977 are important.

> "Given the variable nature of pollutant discharges from separate storm sewers and agricultural point sources, and the inability to impose nationally applicable substantive requirements at this time, most first generation general permits will authorize current discharges. However, a failure to develop and implement adequate 208 plans may compel more substantive restrictions in second generation general permits or in individual permits, which could include conventional effluent limitations, management practices, or other appropriate requirements.
>
> * * *
>
> ". . .While it is express policy of EPA to regard planning and problem-solving under Section 208 as a local government function, if it appears that this function is not being carried out, EPA must initiate action to meet the goals of the FWPCAA. An alternative to this general permit program, with its reliance on planning agencies' BMP recommendations, could be the issuance of individual NPDES permits imposing effluent limitations on the point sources identified in the agricultural activities and separate storm sewer categories. This alternative, as it has often been expressed, is not as environmentally or administratively sound as the general permit concept incorporating BMP's. Thus, planning agencies and their affected constituency are strongly encouraged to work together to develop feasible, workable, environmentally beneficial plans to integrate this general permit program into the local decision-making process."